PB-240 503

BIRCH LAKE, CASS COUNTY, MINNESOTA

Pacific Northwest Environmental Research Laboratory

Prepared for:

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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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REPORT
ON
BIRCH LAKE
CASS COUNTY
MINNESOTA
EPA REGION V
WORKING PAPER No. 145

WITH THE COOPERATION OF THE
MINNESOTA POLLUTION CONTROL AGENCY
AND THE
MINNESOTA NATIONAL GUARD
JANUARY, 1975

II

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS*

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

* The lake discussed in this report was included in the National Eutrophication Survey as a lake of special interest to the Minnesota Pollution Control Agency. For this reason, tributaries and nutrient sources were not sampled, and this report relates only to data obtained from lake sampling.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Minnesota Pollution Control Agency for professional involvement and to the Minnesota National Guard for conducting the tributary sampling phase of the Survey.

Grant J. Merritt, Director of the Minnesota Pollution Control Agency, John F. McGuire, Chief, and Joel G. Schilling, Biologist, of the Section of Surface and Groundwater, Division of Water Quality, provided invaluable lake documentation and counsel during the course of the Survey; and the staff of the Section of Municipal Works, Division of Water Quality, were most helpful in identifying point sources and soliciting municipal participation in the Survey.

Major General Chester J. Moeglein, the Adjutant General of Minnesota, and Project Officer Major Adrian Beltrand, who directed the volunteer efforts of the Minnesota National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

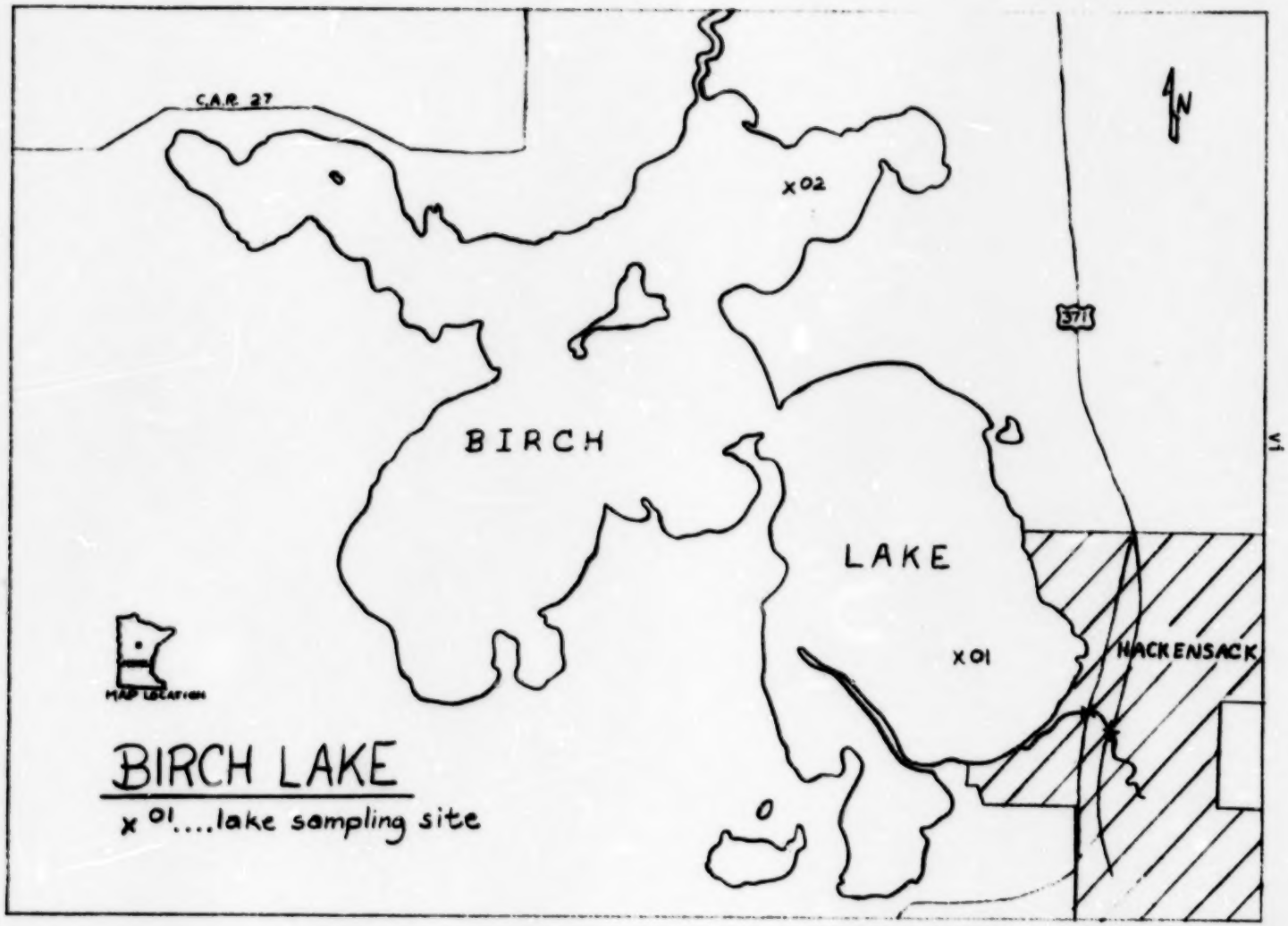
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MINNESOTA

LAKE NAME	COUNTY
Albert Lea	Freeborn
Andrusia	Beltrami
Badger	Polk
Bartlett	Koochiching
Bear	Freeborn
Bemidji	Beltrami
Big	Stearns
Big Stone	Big Stone, MN; Roberts, Grant, SD
Birch	Cass
Blackduck	Beltrami
Blackhoof	Crow Wing
Budd	Martin
Buffalo	Wright
Calhoun	Hennepin
Carlos	Douglas
Carrigan	Wright
Cass	Beltrami, Cass
Clearwater	Wright, Stearns
Cokato	Wright
Cranberry	Crow Wing
Darling	Douglas
Elbow	St. Louis
Embarass	St. Louis
Fall	Lake
Forest	Washington
Green	Kandiyohi
Gull	Cass
Heron	Jackson
Leech	Cass
Le Homme Dieu	Douglas
Lily	Blue Earth
Little	Grant
Lost	St. Louis

LAKE NAME	COUNTY
Madison	Blue Earth
Malmedal	Pope
Mashkenode	St. Louis
McQuade	St. Louis
Minnetonka	Hennepin
Minnewaska	Pope
Mud	Itasca
Nest	Kandiyohi
Pelican	St. Louis
Pepin	Goodhue, Wabasha, MN; Pierce, Pepin, WI
Rabbit	Crow Wing
Sakatah	Le Sueur
Shagawa	St. Louis
Silver	McLeod
Six Mile	St. Louis
Spring	Washington, Dakota
St. Croix	Washington, MN; St. Croix, Pierce, WI
St. Louis Bay	St. Louis, MN; Douglas, WI
Superior Bay	St. Louis, MN; Douglas, WI
Swan	Itasca
Trace	Todd
Trout	Itasca
Wagonga	Kandiyohi
Wallmark	Chisago
White Bear	Washington
Winona	Douglas
Wolf	Beltrami, Hubbard
Woodcock	Kandiyohi
Zumbro	Olmstead, Wabasha


CAR 27
X02
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BIRCH
LAKE
X01
HACKENSACK
N
BIRCH LAKE
X 01....lake sampling site

BIRCH LAKE

STORET NO. 2710

I. INTRODUCTION

Birch Lake was included in the National Eutrophication Survey as a water body of interest to the Minnesota Pollution Control Agency. Tributaries and nutrient sources were not sampled, and this report relates only to data obtained from lake sampling.

II. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Birch Lake is eutrophic. Of the 60 Minnesota lakes sampled in the fall when essentially all were well-mixed, 11 had less mean total phosphorus, 16 had less mean dissolved phosphorus, but none had less mean inorganic nitrogen. Of the 80 Minnesota lakes sampled, nine had less mean chlorophyll a, and 10 had greater Secchi disc transparency.

Near depletion of oxygen with depth occurred at station 2 in July and September.

B. Rate-Limiting Nutrient:

The algal assay results show that Birch Lake was nitrogen limited at the time the sample was collected. However, the lake data indicate phosphorus limitation in September (N/P ratio = 24/1) but a borderline condition in July (N/P = 13/1).

* DNR lake survey map (1957).

III. LAKE MORPHOMETRY*

A. Surface Area: 1,283 acres.

B. Mean Depth: 10 feet.

C. Maximum Depth: 45 feet.

D. Volume: 12,830 acre feet.

IV. PRECIPITATION

A. Year of Sampling: 26.7 inches.

B. Mean Annual: 23.8 inches.

* DNR lake survey map (1957).

V. LAKE WATER QUALITY SUMMARY

Birch Lake was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake and from one or more depths at each station (see map, page vi). During each visit, a single depth-integrated (15 feet or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 4 feet at station 1 and 34 feet at station 2.

The results obtained are presented in full in the Appendix, and the data for the fall sampling period, when the lake essentially was well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to the Appendix.

A. Physical and chemical characteristics:

Parameter	Minimum	Mean	Median	Maximum
		FALL VALUES (10/24/72)		
Temperature (Cent.)	3.1	4.9	5.4	5.4
Dissolved oxygen (mg/l)	10.8	11.3	11.0	12.8
Conductivity (μmhos)	190	207	210	210
pH (units)	8.2	8.2	8.2	8.5
Alkalinity (mg/l)	98	105	106	107
Total P (mg/l)	0.015	0.029	0.030	0.037
Dissolved P (mg/l)	0.009	0.019	0.020	0.026
NO_2 + NO_3 (mg/l)	0.020	0.023	0.020	0.030
Ammonia (mg/l)	0.020	0.023	0.020	0.040
		ALL VALUES		
Secchi disc (inches)	54	96	90	168

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
07/12/72	1. Dinobryon	1,628
	2. Microcystis	253
	3. Cyclotella	229
	4. Anabaena	109
	5. Navicula	96
	Other genera	182
	Total	2,497
09/08/72	1. Chroococcus	1,315
	2. Flagellates	693
	3. Dinobryon	231
	4. Anabaena	90
	5. Cryptomonas	60
	Other genera	272
	Total	2,661
10/24/72	1. Flagellates	2,035
	2. Dinobryon	1,533
	3. Fragilaria	427
	4. Anabaena	201
	5. Cryptomonas	176
	Other genera	1,406
	Total	5,778

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
07/12/72	01	11.7
	02	-
09/08/72	01	1.5
	02	4.0
10/24/72	01	4.9
	02	8.8

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)	N/P Ratio
Control	0.017	0.100	1.4	6/1
0.005 P	0.022	0.100	1.4	-
0.010 P	0.027	0.100	1.3	-
0.020 P	0.037	0.100	1.4	-
0.050 P	0.067	0.100	1.6	-
0.050 P + 10.0 N	0.067	10.100	27.3	151/1
10.0 N	(not done)			

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the primary productivity of Birch Lake was moderate at the time the sample was collected. Also, the lack of significant changes in yields with increasing increments of phosphorus, until nitrogen also was added, indicates that Birch Lake was nitrogen limited at the time of

sampling. The nitrogen/phosphorus ratio in the lake when the sample was collected (about 2.5 to 1) confirms this conclusion. However, the N/P ratio of about 24 to 1 in the September lake sample indicates that Birch Lake may also be phosphorus limited at times (this has been observed in some other Survey lakes, including Shagawa Lake).

VI. APPENDIX

STORET RETRIEVAL DATE 74/10/30

271001
46 56 00.0 094 31 30.0
BIRCH LAKE
27 MINNESOTA

11EPALES
4

2111202
0004 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/12	17 50	0000			72							
	17 50	0004	24.2	10.2		150	8.40	124	0.040	0.040	0.019	0.008
72/09/08	14 40	0000	19.5	9.9	60	180	8.70	88	0.050	0.100	0.012	0.008
72/10/24	09 05	0000	3.1	12.8	54	190	8.50	98	0.030	0.040	0.015	0.010

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/07/12	17 50	0000	11.7J
72/09/08	14 40	0000	1.5J
72/10/24	09 05	0000	4.9J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/10/..

271002
46 56 45.0 094 32 30.0
BIRCH LAKE
27 MINNESOTA

11EPALES
4

2111202
0024 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/12	18 05	0000			168							
	18 05	0004	23.7	6.4		180	7.90	102	0.030	0.040	0.013	0.008
	18 05	0015	21.4	6.4		190	7.60	109	0.040	0.050	0.018	0.013
	18 05	0024	11.7	0.6		205	6.50	117	0.050	0.180	0.015	0.008
72/09/08	14 00	0000			108	215	7.95	111	0.050	0.080	0.019	0.010
	14 00	0004	19.3	8.0		210	7.90	108	0.050	0.060	0.018	0.007
	14 00	0015	18.5	7.7		215	7.90	106	0.050	0.060	0.017	0.006
	14 00	0020	18.4	7.5		215	7.85	105	0.040	0.060	0.016	0.007
	14 00	0027	16.0	1.8		225	7.20	115	0.040	0.120	0.021	0.015
	14 00	0034	8.9	0.3		265	7.10	129	0.080	0.680	0.064	0.007
72/10/24	09 25	0000			115	210	8.20	105	0.020	0.020	0.033	0.023
	09 25	0004	5.4	10.8		210	8.20	105	0.020	0.020	0.034	0.026
	09 25	0015	5.4	11.0		210	8.20	106	0.020	0.020	0.037	0.026
	09 25	0022	5.4	11.0		210	8.20	107	0.020	0.020	0.027	0.018
	09 25	0029	5.3	10.8		210	8.20	106	0.030	0.020	0.027	0.009

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/09/08	14 00	0000	4.0J
72/10/24	09 25	0000	8.4J

J VALUE KNOWN TO BE IN ERROR